Bacterial Counts in Stall Bedding Either Deeply Packed or Lightly Bedded with Recycled Manure Solids

Caleigh Payne
Department of Animal Sciences
The Ohio State University

ABSTRACT

On-farm recycling of manure solids for use as bedding on dairy farms reduces transportation costs for manure application, reduces bedding costs, and provides a sustainable approach to utilizing manure with minimal impact on the environment. A disadvantage to using recycled manure solids as bedding for dairy cows is the potential exposure of cows to fecal-borne bacteria that can result in mastitis and reduced milk quality. An experiment was conducted to determine if the potential risk to pathogen exposure could be reduced by limiting the amount of bedding in each stall. Fifteen lactating Holsteins cows were housed in one pen with unlimited access to 18 stalls. Nine of the stalls were bedded with 100 to 150 mm of recycled manure solids, while the remaining 9 stalls were bedded with vinyl surfaced mattresses covered in 25 to 50 mm of recycled manure solids. Overall, surface bacterial counts of Gram-negative bacteria, coliforms, and *Klebsiella* species in recycled manure solids were similar between the deep bedded stalls and mattress covered stalls bedded with a thin cover of recycled manure. Surface counts of streptococcal bacteria were reduced in deep bedded stalls compared with mattress covered stalls with a thinner covering of recycled manure. These results indicated that additional bedding in stalls for cow comfort did not increase the risk of exposure to potential mastitis causing pathogens.

INTRODUCTION

Mastitis is an infectious disease of the mammary gland that negatively affects the amount of milk produced, adversely impacts the manufacturing quality of milk, increases the risk of food borne pathogens to consumers, and creates a condition whereby the health and welfare of the cow can be adversely affected. Controlling the incidence of mastitis is based upon reducing the exposure of cows to mastitis pathogens in their environments. Bedding in stalls is very closely tied to the bacterial exposure of the cows due to the fact that cows spend 8 to 16 hours daily lying down with their udders coming in contact of the stall surface material (Tucker et al., 2009). Complicating the assessment of disease risk attributed to bedding is the fact that bedding cost is one of the highest expenses on the dairy farm. Manure is a readily available byproduct of dairy cows. Bedding with recycled manure solids allows the use of the waste and promotes profitability of anaerobic digestion that produces manure solids as a byproduct of the process (Gooch et al., 2006). The amount of recycled bedding to use to fill the stalls is a potential conflict between cow comfort and potential increased risk to pathogen exposure. The deeper the bedding pack, the more cow comfort, less hock lesions, and less leg injuries are sustained by the cows (Tucker et al., 2004). In contrast, the potential negative implications of using deep bedding packs are the increased volume of organic matter and moisture may promote higher counts of mastitis-causing bacteria. However, direct comparisons of bacterial counts in deeply packed and lightly packed free-stalls bedded with recycled manure solids are lacking.

OBJECTIVE

The objective of this experiment was to determine the effects of bedding depth of recycled manure solids on bacterial counts in the bedding for dairy cows in free-stall housing.

EXPERIMENTAL DESIGN

A 6 week study was conducted at the Ohio Agricultural Research and Development Center Krauss Dairy Center in Wooster, Ohio during July and August, 2012. Fifteen lactating Holsteins cows were housed in 1 pen with unlimited access to 18 stalls. For 3 weeks, 1 row of 9 stalls was bedded with 100 to 150 mm of recycled manure solids, while the remaining row of 9 stalls was bedded with vinyl surfaced mattresses covered in 25 to 50 mm of recycled manure solids. Manure and wet bedding was removed from stalls twice daily. Recycled manure solids were added to deeply packed stalls weekly to maintain 100 to 150 mm of bedding. Bedding was completely removed from mattresses weekly and recycled manure solids added to a depth of 25 to 50 mm. Stalls received the same treatment for 3 consecutive wk. After 3 weeks with a specific bedding treatment, the bedding treatments were changed between rows. The trial was conducted for 6 weeks so that stalls were exposed to both bedding treatments in a switch-back design to account for differences among stalls.

Four stalls per treatment group were sampled each morning Monday through Thursday. The samples were tested for dry matter (DM) composition and bacteriological counts. Each sample was taken from the top 25 mm of bedding in the back one-third of each stall. Two grams of sample were placed in a gravity convection oven at 100^0 C for 24 hr and DM determined. Ten grams of bedding was added to 90 ml of sterile saline and mixed for 30 seconds in a blender

(Stomacher Lab-Blender 400; Tekmar Co., Cincinnati, OH). The solution was diluted out into 225 ml of sterile saline and plated on the surface of MacConkey agar (Beckman Dickinson Microbiology Systems, Cockeysville, MD), MacConkey-inositol-carbenicillin agar (MCIC) with Inositol (10 mg/L;Sigma Chemical Co., St. Louis, MO) and carbenicilliin (75 mg/L;Pfizer Co., New York, NY), and Edwards modified media agar containing 5 mg/L colistin sulfate and 2.5 mg/L oxolinic acid (Beckman Dickinson Microbiology Systems, Coceysville, MD) with 50 ml/L of bovine plasma added. Dilutions plated on all media were $1:10^2$ to $1:10^6$. Agar plates were incubated aerobically at 37^0C for 24 hr. Counts were expressed as $\log_{10}$ colony forming units per gram of DM of bedding.

STATISTICAL ANALYSIS

Bacterial counts and DM of bedding samples were analyzed by ANOVA (SAS Institute, Inc., Cary, NC). The main effects for bacterial counts were bedding, stall, and week of period.

RESULTS

Bacterial counts did not differ between deeply and lightly bedded stalls at time of bedding application on day 0. Streptococcal species counts were greater ($P < 0.001$) in lightly bedded stalls than in deeply bedded stalls on days 1, 2, and 7 (Figure 1). Coliform and *Klebsiella* counts were greater ($P < 0.05$) in deeply bedded packs than in lightly bedded stalls on day 7 (Figures 2 and 3). Coliform and *Klebsiella* counts did not differ between treatments on d 1 and 2. Total Gram-negative bacterial counts did not differ between treatments on either days 1, 2, or 7 (Figure 4).

DISCUSSION

Bacterial contamination in bedding is positively correlated with the rate of new cases of clinical mastitis in dairy herds (Hogan et al., 1989). Compared with other bedding sources, recycled manure solids is a bedding source shown to be heavily contaminated with mastitis pathogens (Hogan et al., 1989, 1999). Despite the known risk of potentially increasing rates of clinical mastitis, the use of recycled manure solids as bedding on dairy farms has risen in popularity due to its availability and costs. The present trial was conducted to determine if reducing bedding depth in stalls would reduce bacterial exposure. The use of lightly bedded stalls offered little advantage over deeply packed stalls in reducing cow exposure to environmental mastitis pathogens when recycled manure solids were the bedding source. In fact, streptococcal counts in bedding were greater in lightly bedded stalls than in deeply bedded packs on days 1, 2, and 7 after bedding was added to stalls. Conversely, deeply bedded packs had higher coliform and *Klebsiella* counts than lightly bedded stalls by 7days. These data imply the use of deeply bedded recycled manure solids packs to maintain cow comfort and health (Tucker et al., 2004) has minimal negative effects on bacterial exposure to mastitis pathogens when compared with stalls lightly bedded with recycled manure solids.

CONCLUSIONS AND IMPACT

- **S**treptococcal counts in stalls bedded with deeply packed recycled manure solids were reduced compared with stalls lightly bedded with recycled manure solids.
- Coliform and *Klebsiella* counts in stalls lightly bedded with recycled manure solids were reduced compared with stalls bedded with deeply packed recycled manure solids only on day 7.

- Despite the depth used in stalls, the recycled manure solids are a potential health risk to cows when used as bedding.

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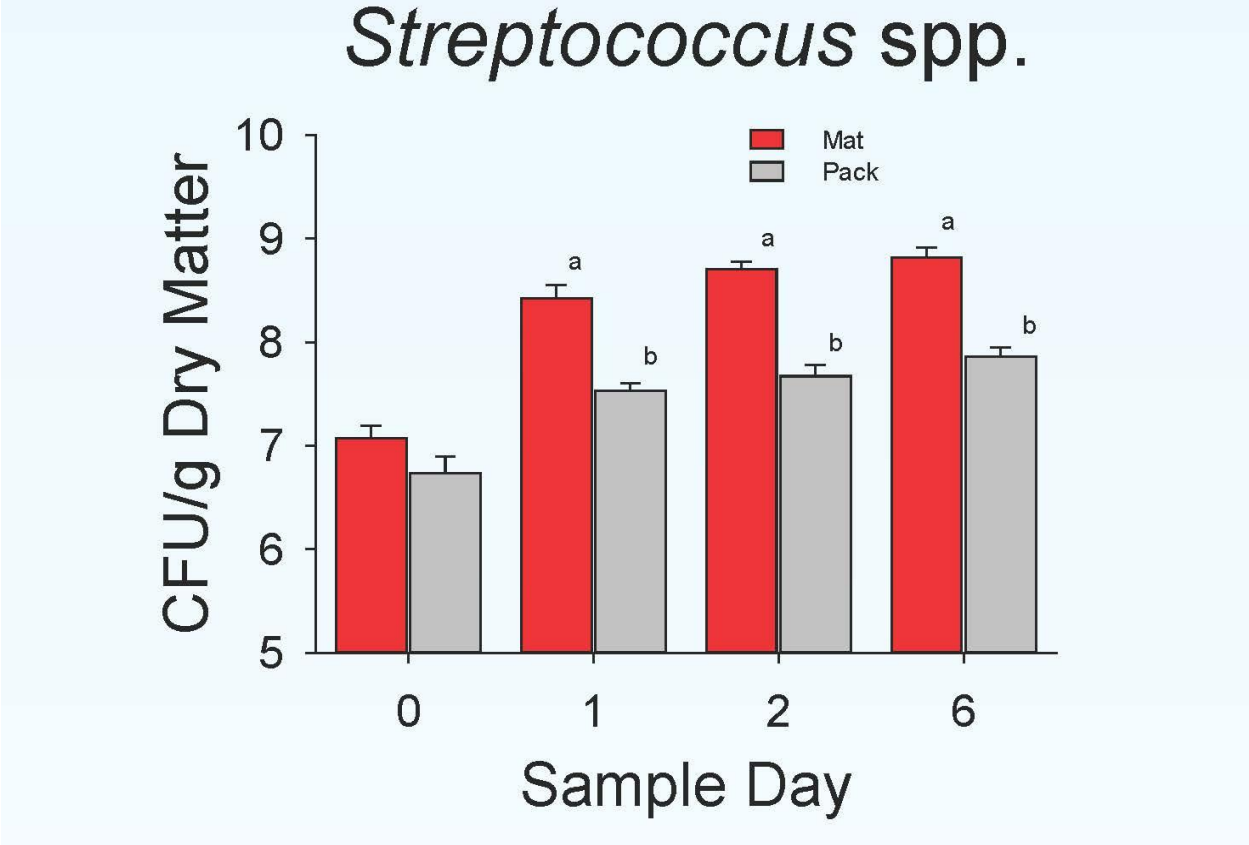

FIGURE 1. Counts for streptococci in the surface 25 mm of recycled manure solids for lactating dairy cows. Stalls were either deeply bedded packs or lightly bedded mattress surfaces in stalls.

[ab] Means within day with differing superscripts differ ($P < 0.001$).

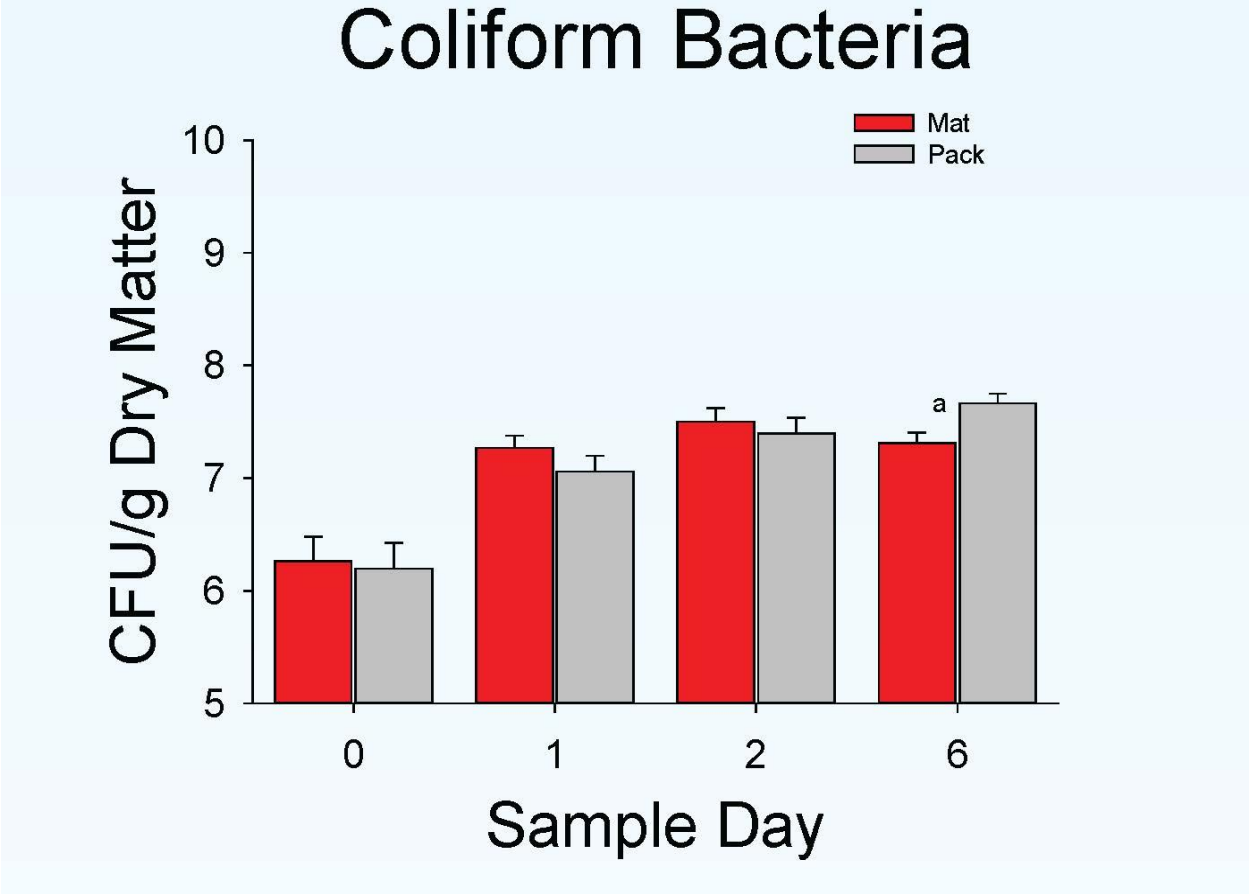

FIGURE 2. Counts for coliform bacteria in the surface 25 mm of recycled manure solids for lactating dairy cows. Stalls were either deeply bedded packs or lightly bedded mattress surfaces in stalls.

[ab] Means within day with differing superscripts differ ($P < 0.05$).

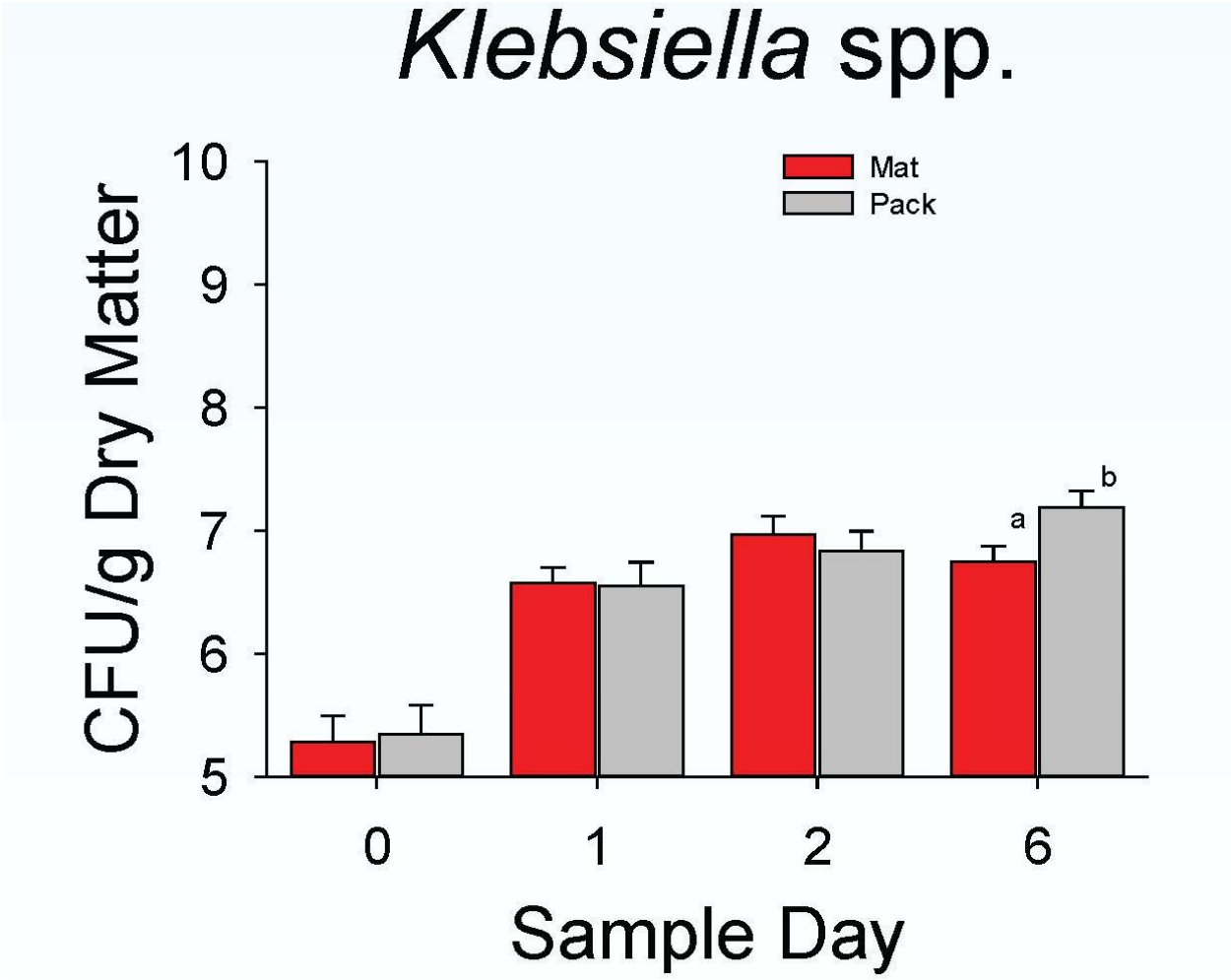

FIGURE 3. Counts for *Klebsiella* in the surface 25 mm of recycled manure solids for lactating dairy cows. Stalls were either deeply bedded packs or lightly bedded mattress surfaces in stalls.

[ab] Means within day with differing superscripts differ ($P < 0.05$).

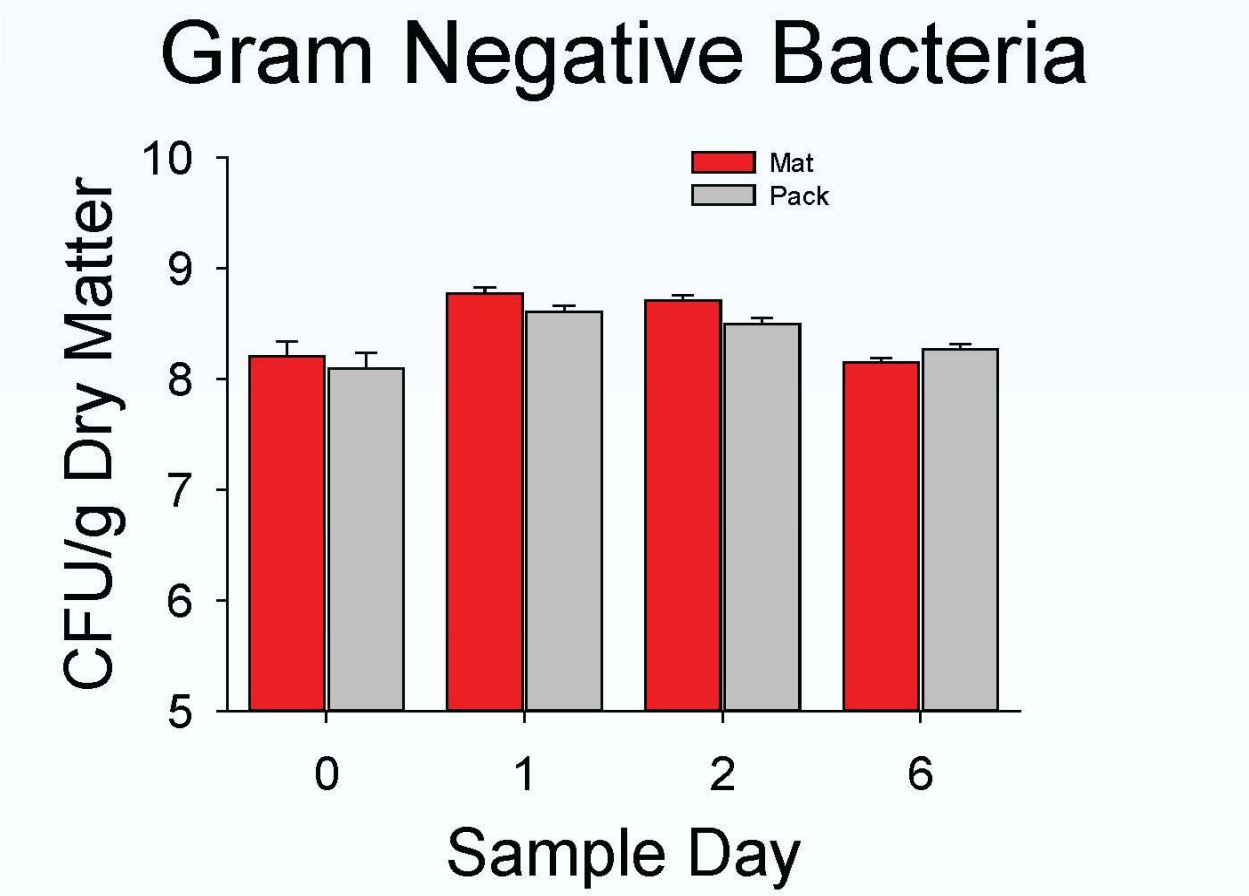

FIGURE 4. Counts for total Gram-negative bacteria in the surface 25 mm of recycled manure solids for lactating dairy cows. Stalls were either deeply bedded packs or lightly bedded mattress surfaces in stalls.